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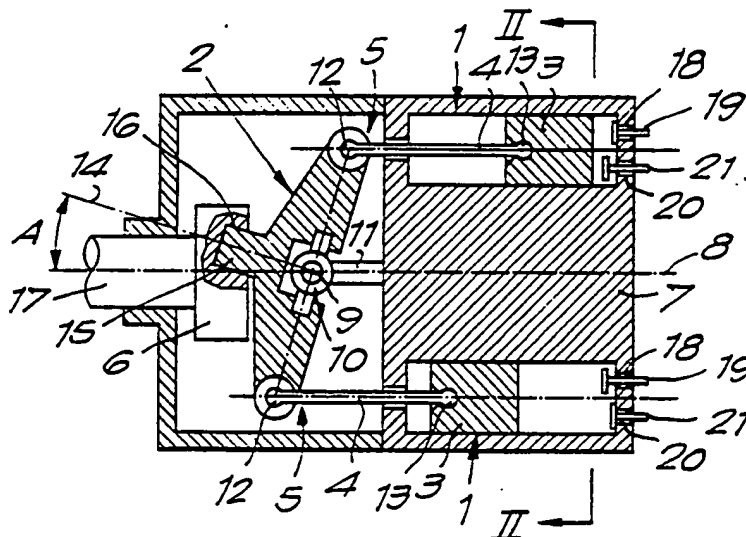
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(71)(72) Applicant and Inventor: MEYLAERS, Linda [BE/BE];  
Verbindingslaan 44, B-2210 Borsbeek (BE).(74) Agent: DONNE, E.; Bureau M.F.J. Bockstael n.v., Aren-  
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(54) Title: PISTON MACHINE



(57) Abstract

Piston machine, characterised by the fact that it basically includes at least one fixed cylinder (1) essentially parallel to a central shaft (8); a tilted plate (2) set around a central point (9) on said central shaft (8), which can tip in all directions; a mobile piston (3) located in the cylinder (1) the rod (4) of which has a free end (5) articulated on the tilted plate (2); and a rotating part (6) which is supported by a bearing in relation to the central shaft (8), on which the tilted plate (2) is connected to said rotating part (6) in an eccentric manner.

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Piston machine.

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This invention relates to a piston machine, more especially to a machine of which the structural construction is both applicable for constructing engines, and for building pumps, compressors or similar.

The purpose of the invention is to provide a machine of which the weight, notwithstanding the use of a large number of cylinders, remains small in relation to the conventional embodiments of piston compressors and piston engines, whereby even a saving of 50% in weight and size can be achieved.

In particular with very large engines, among others ships' engines, this saving is of great importance in view of the transport means which are equipped herewith, on the one hand, have to produce less energy in order to move their own weight and, on the other hand, achieve a greater loading capacity.

The purpose of the present invention is also a piston machine which operates almost noiselessly and with little vibration.

Another purpose of the invention consists in that a piston machine is provided whereby the combustion chambers or compression chambers can be produced in optimum dimensions without having to take into account the stroke lengths and crankshaft size.

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The purpose of the present invention is also a piston machine whereby the piston rods perform an almost rectilinear movement so that almost no lateral pressure is exerted on the pistons through which less friction loss arises.

The intention of the invention is also a piston machine which, when it is produced in the form of an engine, shows almost no tilting effect during operation.

In order to achieve the aforementioned objectives the invention concerns a piston machine, with as characteristic that it principally consists of at least one fixed cylinder arranged mainly parallel in relation to a central axis; a swash plate mounted at an angle, tiltable in all directions around a central point, located on the aforementioned central axis; a piston movable in the cylinder of which the free extremity of the piston rod is connected hingingly to the swash plate; and a rotatable part mounted axially on bearings in relation to the central axis, whereby the swash plate is coupled eccentrically to this rotatable part.

The piston machine can be produced both in the form of an engine and of a compressor or pump.

In a particular embodiment the machine is produced double sided, whereby along both sides of the swash plate a series of cylinders is arranged which work either only as engine, or only as compressor or pump or either partly as engine and partly as compressor or pump.

In order to show better the characteristics according to the present invention, some preferred embodiments are described hereafter, as examples without any restrictive character, with reference to the enclosed drawings, in which:

figure 1 shows schematically and in cross-section the piston machine according to the invention;  
figure 2 shows a cross-section according to line II-II in figure 1;  
figure 3 shows a practical embodiment whereby the piston machine is produced as an engine;  
figure 4 shows a practical embodiment whereby the piston machine is produced at the same time as an engine and as pump or compressor;  
figure 5 shows on larger scale a view of the part that is indicated by F5 in figure 4.

As is schematically shown in figures 1 and 2 the piston machine according to the invention principally consists of at least one, and preferably as shown six circularly arranged cylinders 1; a swash plate 2 tiltable in all directions, mounted at an angle; in the cylinders 1 movable pistons 3 with piston rods 4 of which the free extremities 5 are hingingly connected to the swash plate 2; and a rotatable part 6, whereby the swash plate 2 is eccentrically coupled to this rotatable part 6.

The aforementioned cylinders 1 are preferably arranged in a common cylinder block 7 and are hereby circularly arranged around a central axis 8. The axial axes of the respective cylinders 1 are preferably parallel, or almost parallel to each other.

The swash plate 2 is at a specific angle A to the central axis 8 and can apart from that perform a rotating tilting movement, more especially around a central point 9 that is located on the central axis 8. In order that the swash plate 2 would move smoothly it is preferably hingingly supported in this central point 9, for example by means of a universal joint 10, or possibly a ball and socket joint, whereby this joint or this articulation is attached to a fixed support 11.

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The piston rods 4 are hingingly attached by their free extremities 5 to well defined locations on the swash plate 2, for example by means of ball and socket joints 12. On their extremities near to the pistons 3 they are preferably, but not necessarily, also hingingly connected to the pistons 3, for example also by means of ball and socket joints.

The aforementioned rotatable part 6 is mounted on bearings axially in relation to the central axis 8. The rotatable part 6 and the swash plate 2 are preferably connected to each other by means of parts meshing into each other, which are rotatable in relation to each other according to the perpendicular bisector 14 of the swash plate 2. For this purpose the swash plate 2 has a protruding shaft part 15, directed according to the perpendicular bisector 14, which fits into a seat 16 in the end face of the rotatable part 6.

The operation of the device can easily be deduced from figure 1. In the case where the piston machine is intended to be used as engine, the cylinders 1 are used as combustion chambers or expansion chambers and the successive pistons 3 are moved alternately to and fro with as result that the swash plate 2 performs a rotating tilting movement, which by means of the rotatable element 6 is converted into a rotating movement of the shaft 17.

In the case where the piston machine is used as pump or compressor, the aforementioned shaft 17 is driven, through which the pistons 3 perform a reciprocating movement.

It is clear that the unit is provided in known manner with the necessary intake openings 18, intake valves 19, exhaust openings 20 and exhaust valves 21 in order either to allow an explosion process, or to provide a compression effect.

The present invention is further clarified on the basis of two practical embodiments, respectively according to figures 3 and 4.

Figure 3 shows a double sided produced piston machine according to the invention, in other words whereby along both sides of the swash plate 2 a series, of for example six cylinders 1 are arranged. All piston rods 4 are connected to the same swash plate 2. Although in figure 3 the pistons 3 of the left and right part are presented in a same plane, in practice these lie displaced, such that the ball and socket joints 12 are situated alternately along the periphery of the swash plate 2.

According to figure 3 the shaft 17 extends out through the left cylinder block 7, to outside the engine, where this shaft 17 is preferably provided with a flange 22, to which the part to be driven can be coupled.

The engine of the embodiment shown is of the two-stroke principle with injection. The two-stroke principle is in itself sufficiently known.

A specific detail of the embodiment from figure 3 however consists in that the injection pumps 23 are also driven by means of the swashes plate 2, more especially by piston rods 24 which are coupled to the swash plate 2 on a smaller diameter than the piston rods 4. Fuel is hereby sucked in by the pumps 23 via a pipe not shown and sent via a pipe 25 to the injector 26 in question.

Another special characteristic of the embodiment shown in figure 3 consists in that the intake openings 18 and the intake valves 19 are situated around the respective piston rods 4, with as advantage that the rocking motions of the piston rods 4 do not impede the chambers 27 under the pistons 3 from closing in relation to the intake chambers

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28, this because of the fact that the intake valves 19 can move sideways.

It is clear that the spark plugs 29 are suitably fired, for example by means of a distributor 30 which is electronically controlled by means of an electronic sensor 31 or similar coupled to the shaft 17.

The operation can easily be deduced from figure 3. With the down stroke of the piston, this sucks air in via the intake opening 18, while the air present in the chamber 32 is compressed. When the piston 3 in question has come to the end of its stroke fuel is injected and ignited, with as result that through the explosion the piston 3 is moved back through which the amount of air present in the chamber 27 is first compressed and subsequently sent via a connecting channel 33, in a sufficiently retracted position of the piston 3, to the chamber 32, through which a scavenging occurs, such that the exhaust gases are pressed outward via the exhaust opening 20.

The operation of the swash plate 2 is hereby analogue to the schematic representation from figure 1.

In figure 4 a piston machine according to the invention is shown of which the part on the left of the swash plate 2 in the figure is produced as engine, while the part on the right thereof is produced as compressor.

By way of variant an engine is hereby shown whereby the fuel is not supplied by means of an injector 26, but by atomization, by means of a atomizer 34, which is installed in the air intake 35 of the intake chamber 28.

The cylinders 1 shown in the righthand part of the figure, which provide the compressor operation, are each provided in classic manner with a gas intake channel 36, possibly

provided with a filter 37, that exits via the intake valve 19 into the chamber 32 in question, and a pressure channel 38 connected to the exhaust opening 20 in which the exhaust valve 21 is placed.

The operation of the piston machine according to figure 4 can easily be deduced from this figure. It offers the advantage of being very compact, because the engine and the compressor are directly coupled to each other by means of the swash plate 2. The shaft 17 therefore no longer has any driving function.

As is shown in figure 5 according to the invention the shaft part 15 is preferably mounted in seat 16 by means of an articulation, preferably a ball and socket joint 39. This offers the advantage that the alignment of the shaft part 15 and the seat 16 need not be very precise and that deviations are automatically absorbed, through which wear and tear is almost excluded.

The present invention is in no way restricted to the embodiments described above and shown in the enclosed drawings, but such piston machine can be implemented in all kinds of forms and dimensions, without departing from the scope of the invention.

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## Claims.

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1.- Piston machine, characterised in that it principally consists of at least one, fixed cylinder (1) arranged mainly parallel in relation to a central axis (8); a swash plate (2) tiltable in all directions around a central point (9) located on the central axis (8); a piston (3) movable in the cylinder (1) of which the free extremity (5) of the piston rod (4) is connected hingingly to the swash plate (2); and a rotatable part (6) mounted axially on bearings in relation to the central axis (8), whereby the swash plate (2) is coupled eccentrically to this rotatable part (6).

2.- Piston machine according to claim 1, characterised in that the swash plate (2) is hingingly attached in its central point (9).

3.- Piston machine according to claim 2, characterised in that the swash plate (2) is hingingly attached in its central point (9) by means of a universal joint (10).

4.- Piston machine according to one of the preceding claims, characterised in that the piston rod (4), respectively piston rods (4) are hingingly connected to the swash plate (2), by means of ball and socket joints (12).

5.- Piston machine according to one of the preceding claims, characterised in that the piston rod (4), respectively at least a number of the piston rods (4) are likewise hingingly attached in the pistons (3), by means of ball and socket joints (13).

6.- Piston machine according to one of the preceding claims, characterised in that the rotatable part (6) and

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the swash plate (2) are coupled to each other by means of parts meshing into each other which are in relation to each other rotatable according to the perpendicular bisector (14) of the swash plate (2).

7.- Piston machine according to claim 6, characterised in that the aforementioned meshing parts consist of, on the one hand, a shaft part (15) provided on the swash plate (2) that extend according to the aforementioned perpendicular bisector (14), and, on the other hand, a seat (16) for this shaft part, which is installed at an angle in the rotatable part (6).

8.- Piston machine according to claim 7, characterised in that the shaft part (15) of the swash plate (2) is mounted in the seat (16) of the rotatable part (6) by means of a ball and socket joint (39).

9.- Piston machine according to one of the preceding claims, characterised in that it is produced as an engine.

10.- Piston machine according to claim 9, characterised in that the rotatable part (6) is coupled to the outgoing shaft (17).

11.- Piston machine according to claim 9 or 10, more especially whereby the fuel in the cylinder, respectively cylinders (1) is injected, characterised in that the injection pump, respectively the injection pumps (23) are directly driven by the swash plate (2), more especially by a piston rod, respectively piston rods (24) which are connected to the swash plate (2) on a smaller diameter than the piston rod, respectively piston rods (4) of the piston, respectively piston (3).

12.- Piston machine according to claim 9, 10 or 11, characterised in that the intake valve (19) of the

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cylinder (1), respectively intake valves (19) of the cylinders (1) as well as the intake opening, respectively intake openings (18) surround the piston rod, respectively piston rods (4), whereby the intake valve, respectively intake valves (19) follow the rocking lateral motion of the piston rod, respectively piston rods (4).

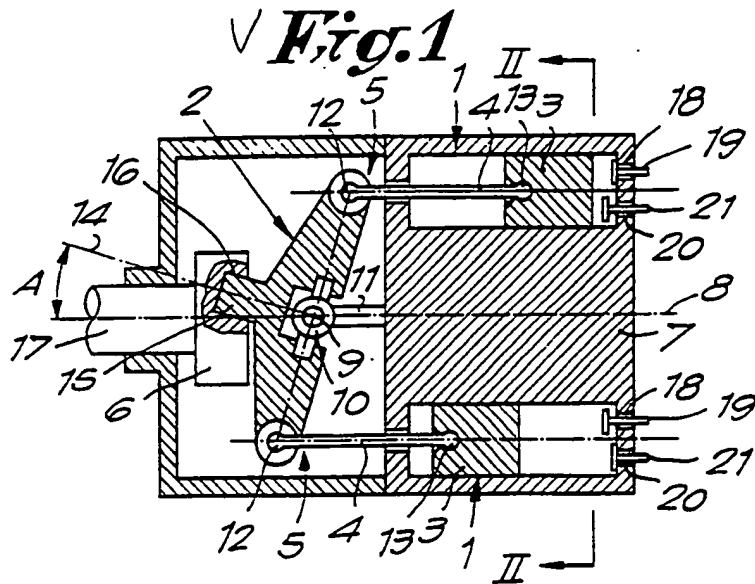
13.- Piston machine according to one of the preceding claims 1 to 8, characterised in that it is produced as a pump or compressor.

14.- Piston machine according to one of the preceding claims, characterised in that on both sides of the swash plate (2) a series of cylinders (1) is arranged, of which the piston rods (4) work together with one and the same swash plate (2).

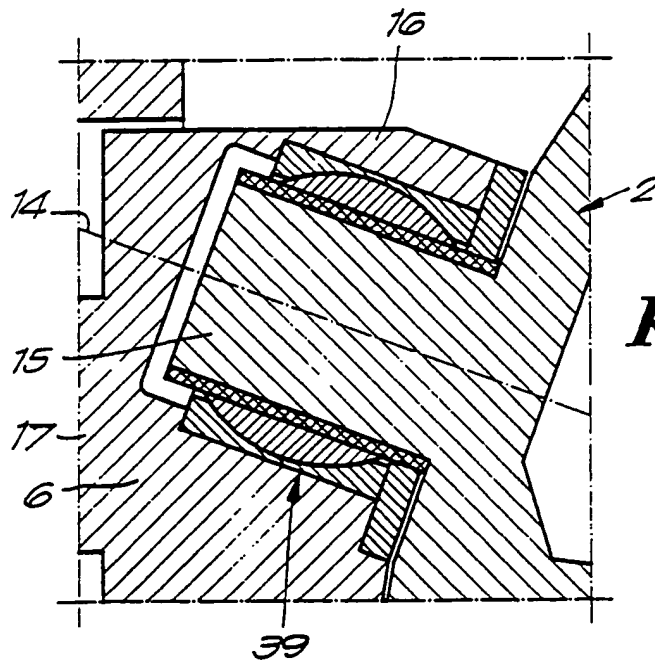
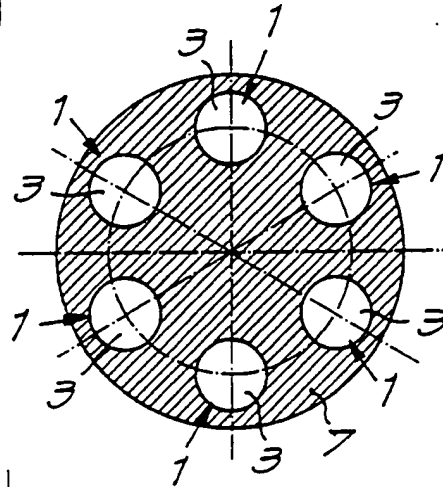
15.- Piston machine according to claim 14, characterised in that a number of the cylinders are produced as engine, while the remaining cylinders function as pump or compressor.

16.- Piston machine according to claim 15, characterised in that all cylinders (1) which are along one side of the swash plate (2) function as engine, while all cylinders (1) are on the opposite side of the swash plate (2) are produced as pump or compressor.

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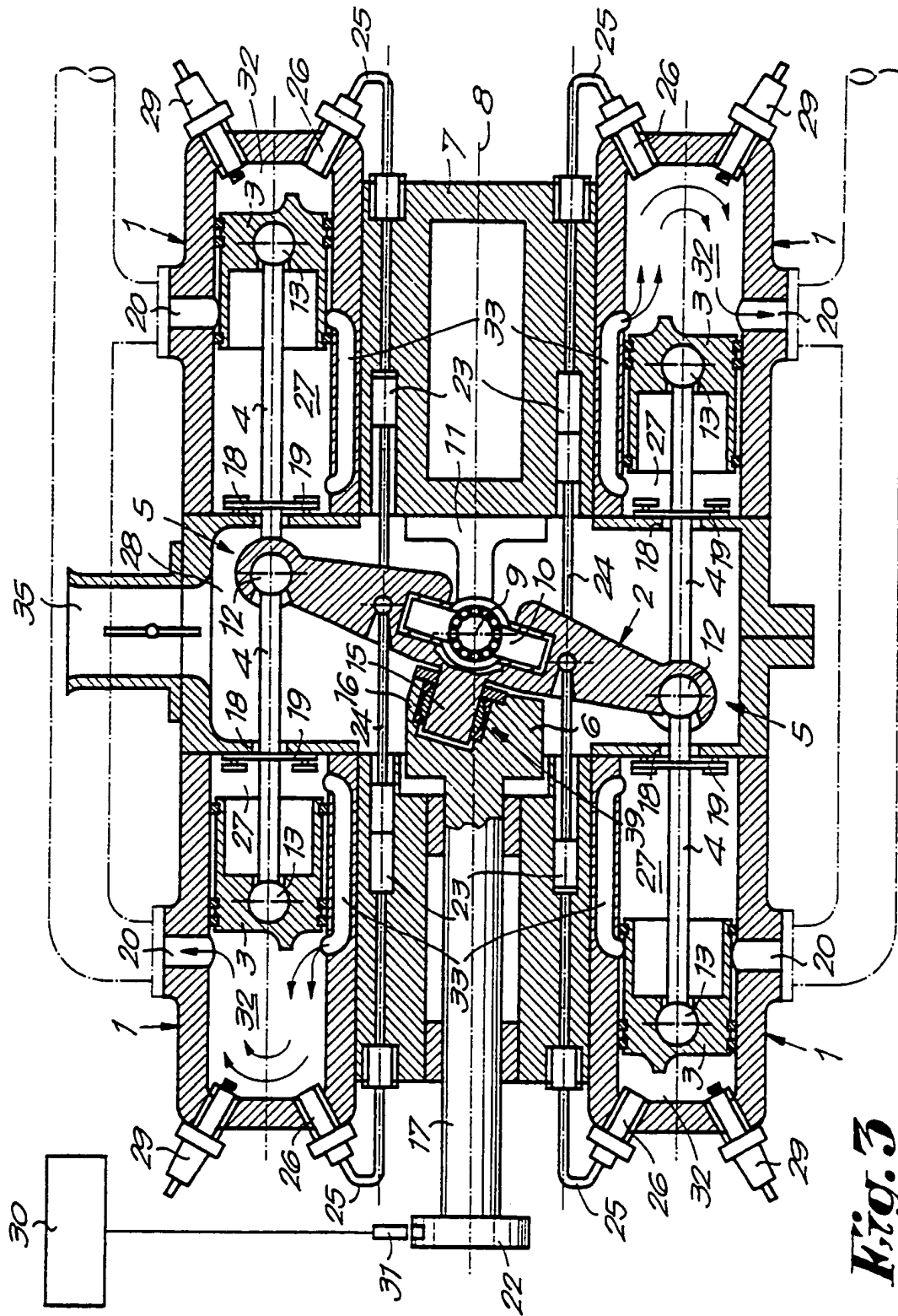


**Fig. 2**

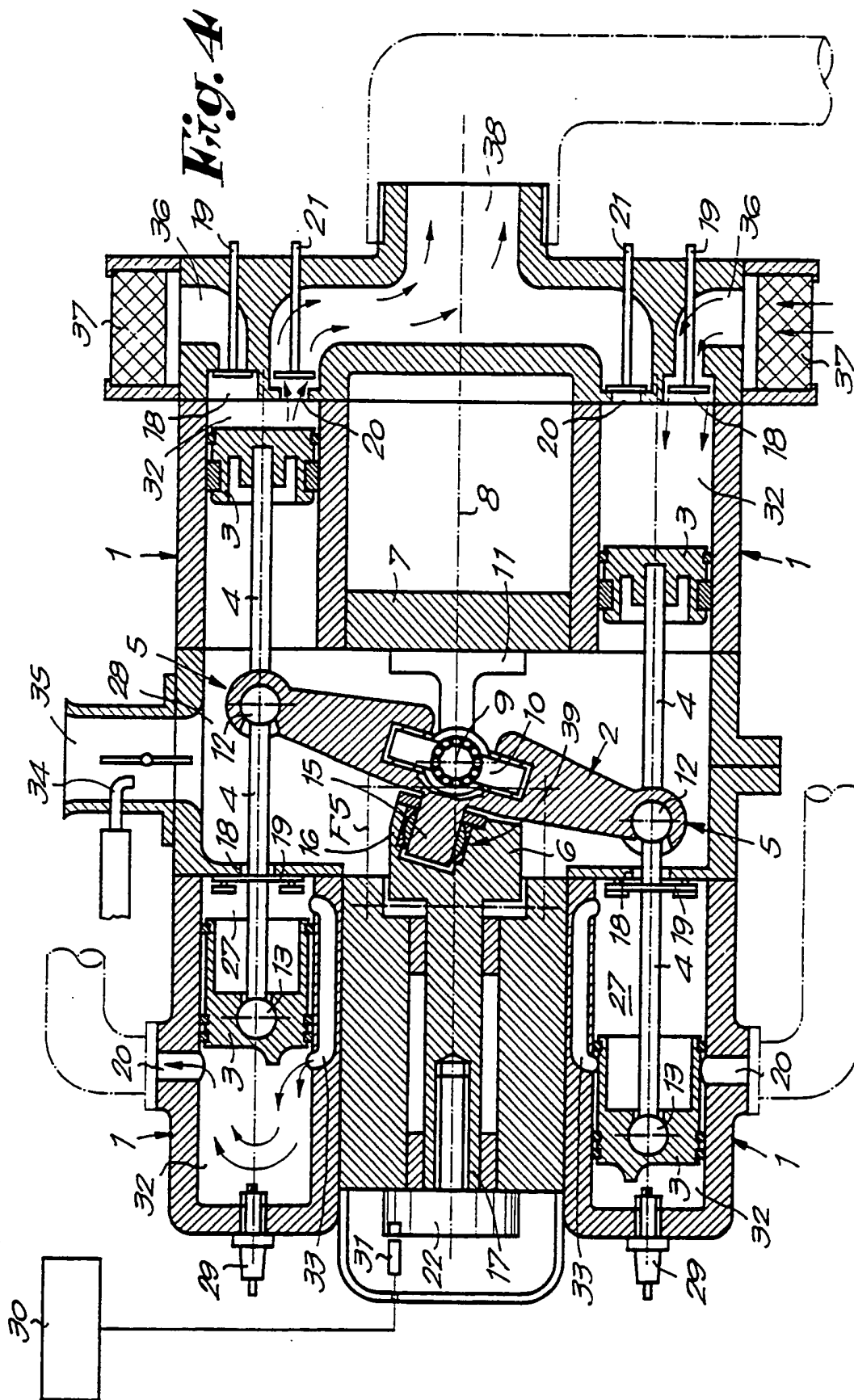


**Fig. 5**

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- 3/3 -



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/BE 90/00047

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) * According to International Patent Classification (IPC) or to both National Classification and IPC Int.Cl. <sup>5</sup> F 02 B 75/26; F 01 B 3/02																				
<b>II. FIELDS SEARCHED</b> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Minimum Documentation Searched †</div> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border-bottom: 1px solid black;">Classification System</th> <th style="width: 75%; border-bottom: 1px solid black;">Classification Symbols</th> </tr> <tr> <td style="border-right: 1px solid black; padding: 5px;">Int.Cl.<sup>5</sup></td> <td style="padding: 5px;">F 02 B; F 01 B</td> </tr> </table> <div style="text-align: center; border-top: 1px solid black; border-bottom: 1px solid black;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *</div>			Classification System	Classification Symbols	Int.Cl. <sup>5</sup>	F 02 B; F 01 B														
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Int.Cl. <sup>5</sup>	F 02 B; F 01 B																			
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT ‡</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category *</th> <th style="width: 60%; border-bottom: 1px solid black;">Citation of Document, †† with indication, where appropriate, of the relevant passages †‡</th> <th style="width: 30%; border-bottom: 1px solid black;">Relevant to Claim No. †‡</th> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>EP, A, 155487 (HITACHI) 25 September 1985 see the whole document ---</td> <td style="vertical-align: top;">1-10,13</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>NL, C, 64469 (BRUINSHORST) 16 May 1949 see the whole document ---</td> <td style="vertical-align: top;">1-10</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">X</td> <td>FR, A, 1457610 (CHARCOSSET) 04 November 1966 see the whole document ---</td> <td style="vertical-align: top;">1-11,13</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>FR, A, 2517742 (GIRODIN) 10 June 1983 see the whole document ---</td> <td style="vertical-align: top;">1-10</td> </tr> <tr> <td style="text-align: center; vertical-align: top;">A</td> <td>FR, A, 1450354 (POIX) 26 April 1966 see the whole document -----</td> <td style="vertical-align: top;">1-10</td> </tr> </table>			Category *	Citation of Document, †† with indication, where appropriate, of the relevant passages †‡	Relevant to Claim No. †‡	X	EP, A, 155487 (HITACHI) 25 September 1985 see the whole document ---	1-10,13	X	NL, C, 64469 (BRUINSHORST) 16 May 1949 see the whole document ---	1-10	X	FR, A, 1457610 (CHARCOSSET) 04 November 1966 see the whole document ---	1-11,13	A	FR, A, 2517742 (GIRODIN) 10 June 1983 see the whole document ---	1-10	A	FR, A, 1450354 (POIX) 26 April 1966 see the whole document -----	1-10
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<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: †‡</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>																				
<b>IV. CERTIFICATION</b> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">           Date of the Actual Completion of the International Search            22 November 1990 (22.11.90)         </td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">           Date of Mailing of this International Search Report            5 December 1990 (05.12.90)         </td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">           International Searching Authority            European Patent Office         </td> <td style="border-bottom: 1px solid black; padding: 5px;">           Signature of Authorized Officer         </td> </tr> </table>			Date of the Actual Completion of the International Search 22 November 1990 (22.11.90)	Date of Mailing of this International Search Report 5 December 1990 (05.12.90)	International Searching Authority European Patent Office	Signature of Authorized Officer														
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# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

BE 9000047  
SA 39542

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-155487	25-09-85	JP-A- 60164677	27-08-85
NL-C-64469		None	
FR-A-1457610		None	
FR-A-2517742	10-06-83	None	
FR-A-1450354		None	

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